Operatore 4.0: l’operatore ai tempi dell’industria moderna

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Short bio

Associate Professor Engineering Dept. “Enzo Ferrari” UNIMORE
Co-founder of the XiLab research Lab (X-in-the-Loop) www.xilab.unimore.it

Professor of the following University Courses
- Technical Drawing (Degree in Mechanical Engineering)
- Virtual Prototyping (Master Degree in Innovation Design)
- User Experience Design (Master Degree in Mechanical Engineering / Informatics)

Professor of Industrial Courses about:
- UX design / Interface design
- Human Factors and Ergonomics
- Virtual Reality / Augmented Reality technologies
- Design to Cost

Founding member of a University spin-off Hyperlean Srl www.hyperlean.eu
Author of more than 130 publications on international journals and conferences
Associate Editor / Guest Editor of IJCIM, IJASM, JIII, JIIM
Program Chair of several international conferences
Conference Chair of TE2018, Modena, Italy
2 main research areas:
→ Robotics and automation
→ UX and Virtual Prototyping / Virtual Reality

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Industry 4.0

**INDUSTRY 4.0 = 4th Industrial Revolution**

A revolution is a fundamental change in organizational structures that takes place in a relatively short period of time and creates a significative technological GAP (adoption of new technologies is not enough...)

**MACHINES become INTELLIGENT!**

- Able to interpret the environment where they operate and autonomously define the best actions and strategies to achieve the pre-defined goals
- Able to autonomously learn and improve the performances from previous experience

Industry 4.0 and benefits

**INTELLIGENT MANUFACTURING**

Intelligent production systems based on KNOWLEDGE, able to UNDERSTAND, INTERPRET and DECIDE how to work to achieve the best performance according to the external environment

- Higher product quality
- Higher product personalization and flexibility
- Real “Just in Time” production
- Process reconfigurable and «repurposing»
- Maximum OEE avoiding downtime and failures
- Optimized training for workers
- ...
Industry 4.0 and challenges

NEW WORKING CONDITIONS for PEOPLE

Intelligent production systems are evolving from machines to computers!!

- **Reduction of hazardous jobs** thanks to machine / robots (highly repetitive tasks, heavy loads, dangerous situations)
- **Assisting workers categories** (aging workforce, women, less experienced / skilled operators)
- **Less physical work, higher cognitive workload**
- **Improved communication between machines / robots and people**
- **Reduction of team size**
- **Re-organization** of activities
- **Greater potential for remote working**
- ...

Operators in Industry 4.0

**OPERATOR 1.0**
Manual and Dextrous work + Manually operated machine tools

1960

First modern factory: Matthew Boulton’s Soho Manufactury (1961)

**OPERATOR 2.0**
Assisted work + CASE Tools, NC Oss & Enterprise info. systems

1970

Numerical control (1960s) MRP I (late 1960s) towards Automation & control

**OPERATOR 3.0**
Cooperative work with robots, machines & computer tools

2000

Industrial Robots introduction (late 1970s) towards Human-Robot Collaboration

**OPERATOR 4.0**
Work aided by machines (H-CPS)

2019

From Cyber-Physical Systems towards Human-CPS
Operator 4.0 and technological support

- Innovative interfaces (wearable, environmental, ...)
- Advanced supports (physical and cognitive)
- Support to communication with machines
- Monitoring of health conditions

Operator 4.0 and UX

In order to satisfy the operators’ needs, predict their request and find the best to assist in their work …… we should understand their USER EXPERIENCE
Operator 4.0 and UX

UX refers to a subjective emotions and attitudes about using a particular product, system or service. It affects the practical, experiential, affective, meaningful and valuable aspects of interaction with any kind of system.
Operator 4.0 and UX

UX is dynamic: it can be constantly modified and can change along the interaction lifecycle

BEFORE USE
Expectation of a product

DURING USE
Interaction with a product

AFTER USE
Perception after using a product

Usability
User Experience

Operator 4.0 and UX

User experience data analytics
Physiological and biomechanical data analysis
Physical and mental stress/strain detection
More comfortable and satisfying working conditions / Factory optimization

User centered Design
Human-machine intelligent coordination
Support to frail users
AI driven mechatronics

HMI evolution
Cognitive systems and computational cognitive architectures
Multisensory Augmented Reality
Virtual presence for remote operations
HMI evolution

HMI evolution includes NEW INTERFACES / LOCAL AND REMOTE DEVICES AND TECHNOLOGIES regards:

- Progressing towards and Artificial Intelligence paradigm - Cognitive systems and computational cognitive architectures
- Including new classes of feedback - Haptic, acoustic and virtual interaction with virtual and augmented reality scenes - Virtual and Augmented reality - Multimodal perception and multimodal virtual environments
- Virtual presence in remote operation - Virtual Support by Augmented reality - Virtual training using both Virtual and Augmented Reality
Human task design and layout optimization

Virtual Assembly / Virtual Training / Virtual Maintenance
VR for human-robot collaboration

UX analysis in VR-AR

- Immersive VR
- 3D simulation
- Motion capture
- Hand gesture recognition
- Eye Tracking
- 3D Sound
- Physiological data
  - ECG (HR, HRV)
  - Breath Rate
  - Body posture / Accelerations
  - EEG

Eye-view

- PERFORMANCE
- STRESS
- TASK COMPLEXITY
- WORKLOAD
- ATTENTION

- PHYSIOLOGICAL DATA
- ECG (HR, HRV)
- Breathing Rate
- Body posture / Accelerations
- EEG
AR as innovative interface

- Providing contextual information (labels, 3D models, …)
- Checking the sequence of actions
- Showing related information (PMIs, colours, …)

AR benefits for Operator 4.0

- INCREASED EFFICIENCY
- REDUCED COMPLEXITY
- INCREASED SAFETY
- INCREASED COOPERATION
- INCREASED PRODUCTIVITY